

## CLAIMS

What is claimed is:

- 1     1.     A wafer cluster tool comprising:  
2                     a plurality of processing stations for processing wafers, each  
3     processing station further comprising  
4                     a process chamber,  
5                     a local clock coupled to the process chamber;  
6                     a master server in communication with the local clock in each  
7     processing station, the master server including  
8                     a master clock;  
9                     timetable software, wherein the timetable software  
10     records a local time for each clock in the plurality of processing stations.
- 1     2.     The wafer cluster tool of claim 1, wherein each processing station  
2             further comprises:  
3                     a CPU coupled to the processing station, wherein the local clock  
4     coupled to the process chamber resides on the CPU;
- 1     3.     The wafer cluster tool of claim 2 further comprising:  
2                     a local area network, wherein the master server is coupled to the  
3     CPU in each processing station via the local area network.

- 1 4. The wafer cluster tool of claim 3, further comprising:  
2 a CPU coupled to the master server, wherein the master clock is  
3 resident on the CPU coupled to the master server.
- 1 5. The wafer cluster tool of claim 1, wherein the timetable software  
2 comprises a relational database.
- 1 6. The wafer cluster tool of claim 1, wherein the master server is coupled  
2 to the CPU in each processing station via the Internet.
- 1 7. The wafer cluster tool of claim 1, wherein the timetable software  
2 comprises a spreadsheet.
- 1 8. The wafer cluster tool of claim 7, wherein the timetable is updated in  
2 real-time.
- 1 9. The wafer cluster tool of claim 1, wherein the master server further  
2 includes scheduling software for the cluster tool.
- 1 10. The wafer cluster tool of claim 9, wherein the scheduling software  
2 includes a pre-determined schedule for the cluster tool.
- 1 11. The wafer cluster tool of claim 10, wherein the pre-determined schedule  
2 is periodic according to a fixed sending period.

1 12. The wafer cluster tool of claim 11, wherein the time recorded on the  
2 local clocks of each processing station is measured in units of the  
3 sending period.

1 13. A method for synchronizing a wafer cluster tool, the wafer cluster tool  
2 including a plurality of process modules, the method comprising:

- 3 a) generating a deterministic schedule for the wafer cluster  
4 tool, the deterministic schedule having a periodicity of a  
5 sending period;
- 6 b) loading a first wafer set into a first process module in the  
7 cluster tool according to the schedule;
- 8 c) in response to loading the first wafer set in the first  
9 process module, resetting a first local clock coupled to  
10 the first process module;
- 11 d) recording a first time from the first local clock in a  
12 timetable, the timetable coupled to the plurality of  
13 process modules, the first time measured in units of the  
14 sending period;
- 15 e) loading a second wafer set into a second process module  
16 in the cluster tool according to the schedule;
- 17 f) in response to loading the second wafer set in the second  
18 process module, resetting a second local clock coupled to  
19 the second process module;

20                   g)     recording a second time from the second local clock in  
21                   the timetable in units of the sending period.

1    14.     The method of claim 13, further comprising:

2                   h)     one sending period after the loading the first wafer set,  
3                   loading a third wafer set into the first process module  
4                   according to the schedule.

1    15.     The method of claim 14, further comprising:

2                   i)     in response to loading the third wafer set, resetting the  
3    first local clock coupled to the first process module.

1    16.     The method of claim 15, further comprising:

2                   j)     recording a third time from the first local clock in the  
3    timetable, the third time measured in units of the sending period.

1    17.     A method for positioning a robot in a wafer cluster tool, the wafer  
2    cluster tool including a first process module, a second process module, and a  
3    third process module, the method comprising:

4                   generating a deterministic schedule for the wafer cluster tool, the  
5    schedule having a periodicity defined by a sending period, wherein the schedule  
6    has a first pickup time for the first module in the cluster tool, and a second  
7    pickup time for the third module, the second pickup time occurring after the  
8    first pickup time, the deterministic schedule including a first instant and a  
9    second instant, wherein the first and second instants are separated by a time  
10   span equal to the sending period;

11 loading a first wafer in the cluster tool at the first instant;  
12 picking up a second wafer from the first module with a robot, the  
13 picking up the second wafer occurring between the first and second instants;  
14 delivering the second wafer from the first module to the second  
15 module with the robot before the second instant;  
16 immediately after the delivering the second wafer, positioning  
17 the robot at the third module, the positioning the robot at the third model  
18 occurring before the second pickup time.

1 18. The method of claim 17 further comprising:

2 delivering the second wafer from the third module to a fourth  
3 module by use of the robot before the second instant.

1 19. The method of claim 18, wherein the robot is an inter bay transfer arm.

1 20. The method of claim 18, wherein the generating the schedule is done by  
2 a linear transformation.

1 21. The method of claim 18, wherein the generating the schedule is done by  
2 a genetic algorithm.

1 22. The method of claim 17, wherein the first module is coupled to a first  
2 local clock, the second module is coupled to a second local clock, the  
3 third module is coupled to a third local clock, and the fourth module is  
4 coupled to a fourth local clock.

1 23. The method of claim 17, wherein the first, second, third, and fourth  
2 modules are coupled by a local area network.

1 24. The method of claim 17, wherein the robot has only one gripper.

1 25. A method of positioning robots in a wafer cluster tool, the wafer cluster  
2 comprising a plurality of process modules, the wafer cluster including a  
3 first robot and a second robot, wherein the wafer cluster tool operates  
4 according to a periodic schedule, the periodic schedule being defined by  
5 a sending period, the method comprising:

6 a) transferring a first wafer from a first process module in  
7 the plurality of process modules to a second process  
8 module in the plurality of modules by use of the first  
9 robot;

10 b) immediately after step a, positioning the first robot at a  
11 third process module

12 c) transferring a second wafer from a third process module  
13 in the plurality of process modules to a fourth process  
14 module in the plurality of modules by use of the second  
15 robot;

16 d) immediately after step c, positioning the second robot at a  
17 fifth process module;

18 wherein steps a through d are conducted within a first time interval, the  
19 first time interval having a duration equal to the sending period.

- 1    26.    The method of claim 25, wherein the first robot and the second robot  
2    each have only one gripper.